

ESTIMATION OF HAND AND FINGER KINEMATICS USING INERTIAL SENSORS

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ABSTRACT

It is the objective within the STW PowerSensor project [1] to develop a glove that is able to assess the dynamic interaction of the human hand with its environment in an ambulatory setting. In the first project phase we will concern about measuring hand and finger kinematics. Current instrumented glove systems are often based on resistive or optical sensors that are placed across the various joints of the human hand and therefore often sensitive to misalignments [2]. We present a new kinematic glove that is equipped with inertial sensors placed on top of the phalangeal segments that can be easily customized for subject specific hand dimensions.

The hand, finger and thumb phalanges are equipped with embedded small-scale 3D rate gyroscope and 3D accelerometer chips. In addition, we instrumented the back of the hand and all fingertips with a 3D magnetometer. Using a custom build data acquisition system, data is transferred to a computer via USB and either stored for later analysis or directly processed.

The integrated output of 3D rate gyroscopes provides an estimate of the orientations of respectively hand and phalanges. Subsequently, by knowledge of various phalangeal lengths we can construct the total transformation matrix, which provides us the positions of all joints and fingertips expressed in a common coordinate frame. As the estimation method is prone to orientation drift, we frequently apply measurement updates using knowledge of joint dimensionalities and the direction of the vertical and magnetic north. The kinematic prediction and correction steps are fused into an error Extended Kalman Filter (EKF) algorithm that is able to provide a real time estimate of the total kinematics.

Preliminary results showed a good estimate of relative orientations during static situations (<1 deg.). The dynamic accuracy is currently evaluated using an optical reference system.

REFERENCES

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